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Volume 8, Number 5 October 1955

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

AMERICAN METEOROLOGICAL SOCIETY

Calendar of National Meetings—1955-56

September 12-15	—Asbury Park, New Jersey
October 3-5	—Stillwater, Oklahoma
November 15-18	—Honolulu, Hawaii
December 27-29	—Atlanta, Georgia
January 23-26	—New York City, New York
May 1-3	—Washington, D. C.
June 19-21	—Seattle, Washington
August 29-31	—Boulder, Colorado
September 5-7	—Albuquerque, New Mexico
October	—Asheville, North Carolina
November	—Cambridge, Massachusetts

Vol. 8, No. 5 October, 1955

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Cover: An artist's visualization of an earth satellite circling the earth. The background is a photograph taken from an experimental rocket at an altitude of 154.8 miles above the launching point in south-central New Mexico. The camera was pointed southeast. The horizon at this altitude is 1120 miles away. The Gulf of Mexico, 650 miles away, would have been plainly visible if there had been no cloud cover over Texas.

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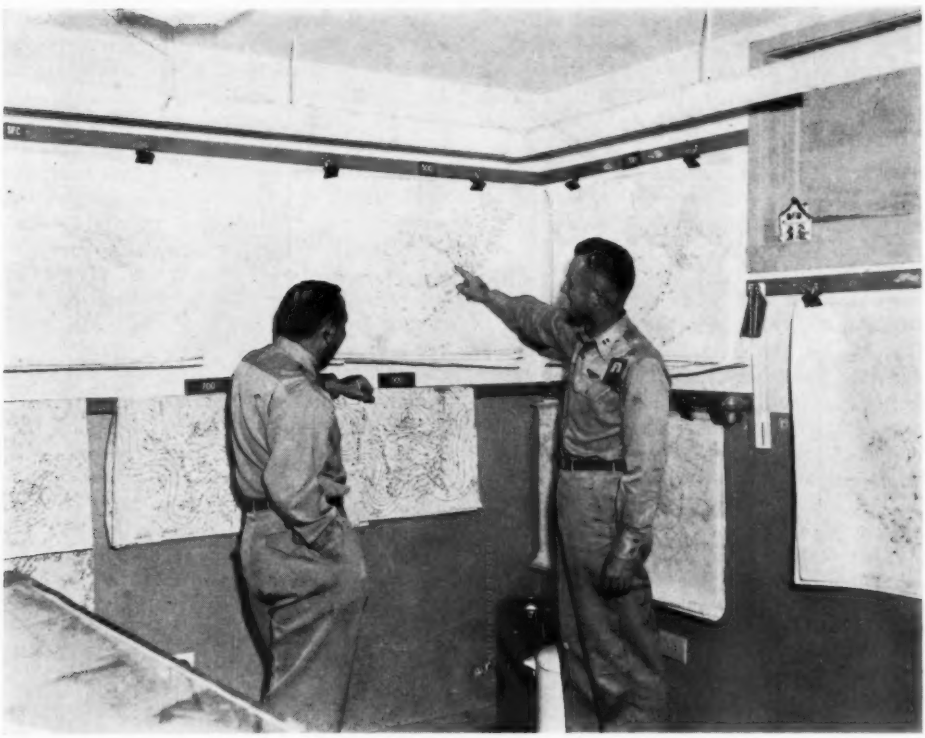


The author on left at the Nevada Test Site prepares for a briefing with Capt. Gentzler. Note classified forecasting device in upper right background. Air Force photo.

Weather Support for the Atomic Tests

LT. COL. CLIFFORD A. SPOHN, *Weather Briefing Officer, Nevada Test Site*

"FIVE, four, three, two . . ." a flat, unemotional voice counts down the seconds. Simultaneously with "zero," an intensely brilliant flash lights up the pre-dawn desert landscape of southern Nevada, and another experimental device of the Atomic Energy Commission has been tested. At the Mercury Weather Station, back at the base camp, the weather forecasters and observers watch the growth of the nuclear cloud with both personal and professional interest. Another forecast has been successfully "sweated out" and in a few minutes it will be time to go back to the plotting boards and prepare the initial forecast for the next "shot." At the same time, across Nevada and its neighboring states, the flash of the explosion is the signal to a widespread group of upper-air sounding stations to make their releases, gathering shot-time and post shot-time data for use in the analysis of many phases of the experiment.

Lt. Colonel Spohn has served as weather briefing officer for many atomic tests. In the tests described in this article he also served as a member of the Advisory Panel to the test Manager. His home station is at Headquarters Air Weather Service where he is Chief of the Evaluation and Development Division of Scientific Services.

This past spring, as in previous test series, the U. S. Air Force Weather Service provided the necessary weather support to the Atomic Energy Commission test series at the Nevada Test Site. This support included all phases of weather activity: forecasting for the operation; observations, both on and off site, throughout the test series; and consultant service to the experimental personnel before and during the tests.

The weather unit this past spring was under the direct control of the test manager, Mr. James Reeves, of the Atomic Energy Commission, Santa Fe Operations Office. Weather Project Officer, and administrative head, was Major Robert McKown. In off-test periods he is staff weather officer to the Armed Forces Special Weapons Project at Albuquerque, New Mexico, as well at detachment commander of the Kirtland Air Force Base weather station.

The weather unit was designed to give maximum service. The forecasting section was composed of personnel who were hand picked from various units of Air Weather Service because of their forecasting ability, and in some cases because of their particular experience and training. Chief forecaster was Lt. Col. Ralph J. Steele of the U. S. Air Force Weather Central. During the spring of 1954 Lt. Col. Steele and most of the forecast personnel spent six weeks at the test site, participating in a "dry-run." This enabled the group to acquire experience with the vagaries of the local weather, settle on an operational routine, and develop teamwork. The 1954 program was especially useful since the forecasting group was new to the job.

The forecasting unit was organized as a small forecast center. Analysis from mid-Pacific to mid-United States was carried out at the surface, 700 mb, and 500 mb levels. Prognoses were prepared for the same levels, with primary emphasis placed on the 500 mb prog. At higher levels, the prognoses from the National Weather Analysis Center were used. If there were marked differences in the 500 mb progs prepared by the National Weather Analysis Center and at Mercury, which could not be resolved, the 300 mb and

TABLE I

WEATHER SUPPORT TIME SCHEDULE

Z Time	PST	Activity
D-2		
0300	1900	Upper Air Observations
0630	2230	Surface Map Observations
D-1		
1230	0430	Surface Map Observations
1500	0700	Morning forecast issued—thirty-six hours forecast made from 0300Z and 0630Z data
1500	0700	Upper Air Observations
1830	1030	Morning Briefing
1830	1030	Surface Map Observations
2100	1300	Special Upper Air Observations from local net and selected U. S. Weather Bureau stations
0030	1630	Surface Map Observations
0200	1800	Evening forecast issued—twenty-four hour forecast from 1500Z and 1830Z data.
0200	1800	Mercury rawinsonde run started
0300	1900	Upper Air Observations
0500	2100	Evening Briefing
0700	2300	Special net upper air observations
D day		
0930	0130	Special net upper air observations
H—1½hours		Early morning briefing
1200	0400	Special net upper air observations
H—hour		Test shot. Special net releases for shot time data.
H + 3 hours		Special net releases for post-shot data
H + 6 hours		Special net releases for post-shot data

Special upper-air sounding network for Nevada Test Site.

200 mb progs from the National Weather Analysis Center were adjusted to conform to the Mercury 500 mb progs. The Mercury station had available, of course, the full schedule of facsimile analyses and prognoses prepared by the National Weather Analysis Center. As an additional backup, the duty forecaster had a daily telephone conference, discussing the analyses and prognoses, with the duty forecaster at the San Francisco Weather Bureau office. This last arrangement had been well coordinated before the test series, one of the forecast shift chiefs having spent several days at the San Francisco office.

In addition to the normal flow of observational teletype reports, the Mercury station had available data from three additional sources as follows:

1. A special upper-air sounding network.
2. Special weather reconnaissance flights.
3. Extra upper-air observations from selected U. S. Weather Bureau stations.

The special upper-air sounding network consisted of four rawinsonde units and seven pibal teams of the 6th Weather Squadron (Mobile). These stations were under the operational control of the chief forecaster. They were used to fill in gaps in the existing synoptic network for a distance of several

Weather Bureau Stations providing special observations for Nevada Test Site.

hundred miles around the test site (see figure 1). Generally, they remained at these locations throughout the test series, although on several occasions a single station was moved, for a particular test, to a more advantageous location.

The 57th Weather Reconnaissance Squadron at Travis Air Force Base provided special weather recon flights on call from the chief forecaster. These were generally additional flights along the Hotel track, north and west of San Francisco, but here also changes from the normal track could be, and were, requested to fit particular situations. These flights helped fill in the big data void in the eastern Pacific, and were frequently the key to the details of a prognosis, or even to the prognosis itself.

To provide additional upper-air data throughout the Southwest, selected U. S. Weather Bureau stations took an additional observation each day at 2100Z (1300 PST). These locations are also indicated on figure 2. The observations were a regularly scheduled, not an on-call, addition.

The operational routine was the same for each shot (see Table I). The first forecast for a particular shot was prepared and issued for the morning briefing of the day prior to the tentative shot-day. This forecast was prepared from 0300Z (1900 PST) data, and was approximately a thirty-six hour forecast. It was issued several hours before briefing time so that the Fall-out Prediction Unit, under Dr. Thomas White, Los Alamos Scientific Laboratory, and the Blast Prediction Unit, under Dr. Everett Cox, Sandia Corporation, would have time to use the forecast in their computations. If the decision at the morning briefing was for a tentative "go-ahead," then preparation of the evening forecast was begun. Because the weather requirements for the shots were so stringent, it was never possible to make a "yes" decision on the basis of forecast conditions. The choice was always between a "no" and a "maybe," with a "maybe" signifying that the forecast indicated sufficient probability of the desired conditions occurring to warrant going ahead. In some cases this meant going ahead even though the probability of favorable weather was less than 50%, so as to be sure not to miss a suitable day.

The evening forecast, made from 1500Z (0700 PST) data, was approximately a twenty-four hour forecast. It also was issued well before briefing time for the preparation of the fall-out and blast predictions. The evening sounding from the Mercury rawinsonde unit was scheduled sufficiently ahead of synoptic time so as to be completed prior to the briefing. The briefing thus consisted of the forecast conditions for the following morning, plus this latest sounding taken immediately prior to the briefing. If the decision was once more for a tentative "yes" (i.e., a "maybe"), the special upper-air sounding network would be alerted. Thereafter, at two to three hour intervals, the stations of the network would take wind soundings to 50,000 feet. Not all the stations were used on every shot, the chief forecaster selecting those from which he wanted the special runs.

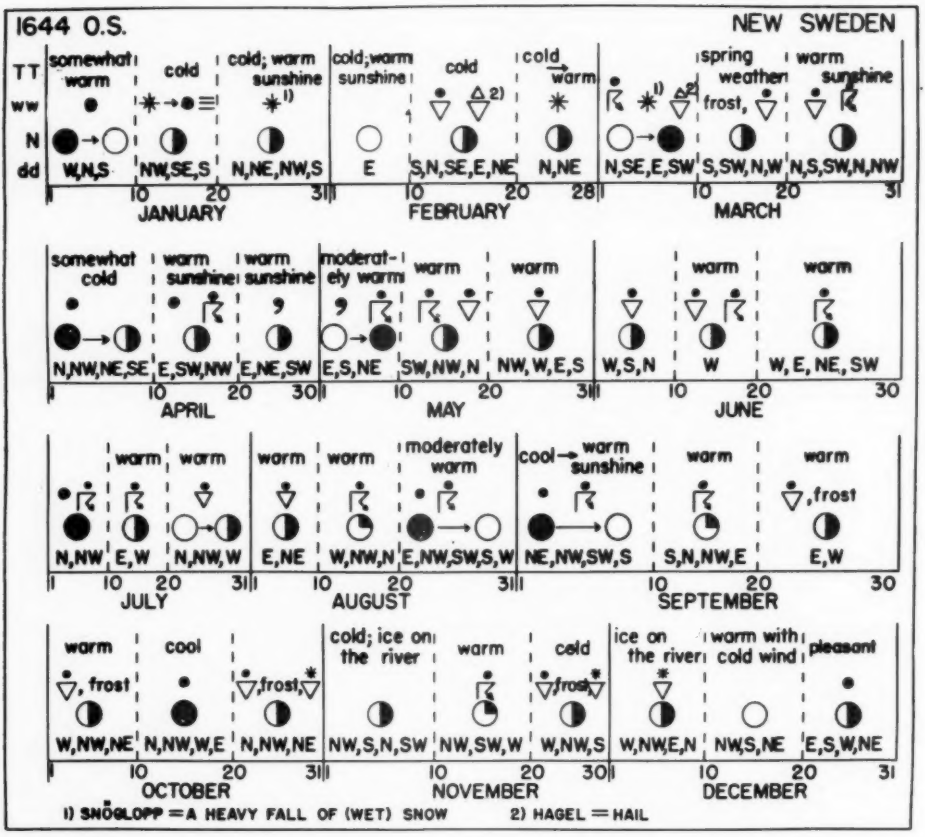
The final briefing would be held about an hour and a half prior to shot time. At that time the data from the special runs were presented, along with the evening forecast and

any adjustments to it. The "short period" sounding data provided a good measure of the accuracy of the forecast and the stability of the situation. From this final evaluation of (a) the current weather, (b) the estimated stability of the weather pattern and (c) the expected rapidity of changes after shot time, would come the final yes or no. If the decision was "yes," the sounding network continued on alert. As a final check, data would be received approximately twenty minutes before shot time from selected stations in the net, to insure that any last minute changes in the wind pattern were not missed. Starting from the shot itself, all stations in the net would take wind runs at three hourly intervals for from six to twelve hours, as required. If the final answer was a "no," then the whole process started again—once more with the preparation of the forecast for the late morning briefing.

On more than one occasion, as those of the readers who followed the "Open Shot" know, the test was turned on and continued on until the final early morning briefing. The cancellation at that late time was not necessarily due to a "busted" forecast. On many occasions a 100% verification of forecast conditions would not have permitted a shot, but there was a sufficient chance of acceptable conditions to warrant "sweating it out." Again, it was the extreme accuracy required, beyond the limits of present forecast ability, which forced this operational procedure. Frequently a shift of the wind of 20°–30° from the forecast direction would change an unacceptable condition to an acceptable one. In retrospect, probably the most critical forecast was really that of determining whether a situation which appeared as suitable at the early morning briefing would continue so through shot time and for a sufficient period thereafter.

(*Continued on page 130*)

Sergeant Tasetana, airmen Butterbuagh and Tregembo, members of a Beatty pibal team at their station. The Test Site terrain is shown in the background. Air Force photo.



The weather for the year 1644 at New Sweden in the present state of Delaware, using conventional weather code symbols.

The "First" Systematic American Weather Observations

JAMES M. HAVENS, *Florida State University*

WHETHER it is the name of the first man to harness the power of steam or the date of the first atomic explosion, history delights in naming and dating famous "firsts." The history of meteorology is no exception, and so it is interesting to trace American meteorological observations back through the decades and centuries to what is believed to be the earliest systematic record of weather data existing for what is now the United States. Such a search can never, of course, be considered complete and final, for there is always the chance that new material will come to light.

In a paper read before the International Meteorological Congress at Chicago in 1894, A. J. Henry credits the "first" meteorological observations to Rev. Johan Campanius, a Swedish chaplain, who accompanied Governor Printz in 1642, to Sweden's New World col-

ony along the mouth of the Delaware River. Today the city of Wilmington is only a few miles north of former Fort Christina, the first Swedish settlement (1631).

Interested in the difference between the climate of New Sweden and that of his homeland, Campanius kept a journal of the weather "every day and night of every month" for the years 1644 and 1645. These observations have been preserved only in abstract form by the observer's grandson, Thomas Campanius Holm, who thought them "too long to be inserted . . . at large" in his slender history of New Sweden, *Kort Beskriftning om Provincien Nya Swerige uti America*. This curious collection of fancy and fact, first published in Stockholm in 1702, was translated by Peter S. du Ponceau in 1833 for the Historical Society of Pennsylvania. Its author, who apparently never visited America, has relied upon the verbal accounts of his father and information from writers who preceded him, chiefly quoting a record left by a Swedish engineer, Peter Lindström, whose manuscript contains descriptions of the climate of New Sweden, based on the author's observations in America during the 1650's. These descriptions are mainly fanciful, as evident from this excerpt: "The winter begins late in November, and sometimes in December, and ends in the middle of January, ... It sets in with great violence; in three or four nights the river will be covered with ice, and when it breaks up, it is with a terrible noise, and there comes immediately fine summer weather. Rain falls there very seldom; it is generally accompanied with thunder and lightning; so that the sky seems on fire, and nothing is seen but flame and smoke."

Fortunately, in abstracting the year 1644, Holm has relied entirely upon his grandfather's written account. The weather of the months, divided approximately into thirds and corresponding to Old Style, or Julian, dating, is given in diagrammatic form in Figure 1. It cannot, of course, be interpreted strictly and in detail. At best it gives a general view of the year's weather.

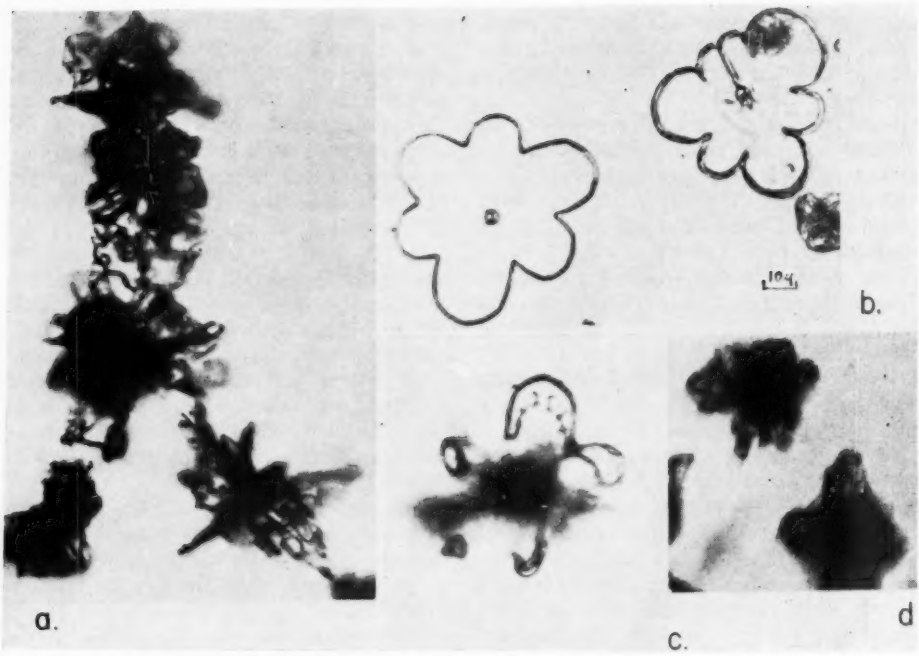
Each component, whether the general temperature TT, characteristic weather ww, cloud cover N, or wind direction dd, is generally presented as a function of time. It should be noted, however, that the winds merely constitute a list and may not be sequential. The same is true for the other components when more than one is listed within each individual one-third month division. Frequently there is, however, some correlation between the components, as listed in the abstract and presented here, suggesting that the listings may indeed be sequential. When no doubt exists as to sequence, an arrow is used.

Du Ponceau's translation of the abstract was checked in detail, errors corrected and omissions included in this diagrammatic sketch. There is always difficulty with definitions of hydrometeors, especially in translations; therefore, where there appears some ambiguity, the Swedish terms are given in footnotes, along with English equivalents as found in Wenström and Lindgren's *Svensk-Engelsk Ordbok* (1925).

The year 1644 in New Sweden appears to have been a rather ordinary one, compared to contemporary climate. No occurrences of severe weather are mentioned in the abstract. From Figure 1 we may conclude that it was a well-watered year, with two periods of general snow, one in late January, the other about the second week in March. Although the severity of the late September frost is not recorded, it occurred about a month before the average date now given for the first killing frost. There seems to have been an abundance of thunderstorms during the spring and summer. Concerning this and the year 1645, Holm comments as follows: "the temperature . . . was mostly similar to that of the preceding (year), except that there was not so much thunder and lightning; but in August and September the heat was greater than in the former year."

Campanius's record is even more appreciated when it is realized that 1644 stands one year after Torricelli's discovery of the principle of the barometer. Daily instrumental temperature observations were first made in England twenty years after Campanius's first year of record; but America had to wait almost a full century for the advent of instrumental observations, first undertaken, as far as is known, by Dr. John Lining near Charleston (1737).

American meteorology, theoretical as well as observational, owes a debt to the scientific curiosity of Rev. Johan Campanius and the army of observers who were to follow.



Figures a, c, d are actual photographs of crystals grown on inorganic soil particles. Figure b is a crystal grown on spores of Lycoperdum gemmatum. Photos by the author.

Simple Experiments in Atmospheric Physics—4

The Formation of Ice Crystals by Sublimation

VINCENT J. SCHAEFER,
Director of Research,
The Munitalp Foundation, Inc.

THE snow which forms in the sky started growing in one of two ways. The particles either developed spontaneously at temperatures colder than − 40° C (where cirrus clouds occur) or formed under special conditions on certain types of small foreign particles floating in the air.

ICE CRYSTALS GROWN FROM WATER VAPOR

Perhaps the most common manner in which crystals form on foreign nuclei is by sublimation. Water molecules filling the air in vapor (gaseous) form deposits on certain types of microscopic particles. This happens only when the air is slightly supersaturated with respect to ice at temperatures colder than 0° C (32° F). Air has the interesting property at all temperatures colder than 0° C that it may become saturated either with respect to ice or with respect to water.

At a temperature of − 14° C the spread between these two conditions is greatest and

amounts to 13%. To saturate air with respect to ice at − 14° C requires 1.51 grams of water per cubic meter of air. To saturate it with respect to water requires 1.74 grams. This means that at − 14° C, under conditions in which ice crystals actively grow, the number of water molecules in the air parcel must be increased by 13% before a water droplet could grow. Of even greater importance is the fact that at all temperatures below 0° C the ice crystal is the stable form. Thus, if cloud droplets and ice crystals occurred together in the air, the ice crystals would grow at the expense of the water droplets until either the droplets were all gone or the crystal became so large it fell away from the supercooled cloud droplets. This phenomenon is of primary importance and will be referred to often in our discussions.

Frost as an Example of Sublimation

A familiar example of the sublimation process is the formation of frost on solid surfaces. Whether formed on a window, a tree, or other object, frost formations develop under conditions in which water molecules deposit out from a clear air situation onto the solid surface. Depending on the nature of the surface, the frost patterns assume various shapes and crystal forms. Many interesting experiments may be conducted to demonstrate these relationships and will be described in a later chapter. For our present discussion, the formation of frost crystals illustrates the sublimation process and indicates what probably occurs on the surface of airborne microscopic particles of the type which are termed sublimation nuclei.

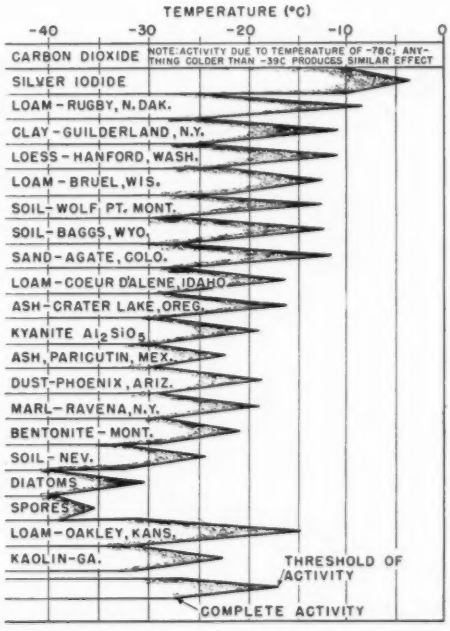
Types of Sublimation Nuclei

There are a variety of sublimation nuclei. Most common are certain kinds of soil particles occurring in arid and semi-arid regions of the world. Perhaps the most effective of these were produced as volcanic dust or from the breakdown of volcanic rocks, due to erosion and similar soil producing actions. Certain water deposited clays are also effective as sublimation nuclei. One of the best samples I have found came from the now dry bed of a post-glacial lake in eastern New York. Clays consist of extremely small particles and have a complex chemical structure. It is probable that the nature of the molecular surface of these tiny particles determines their effectiveness as ice forming nuclei. Figure 1 illustrates temperature range of activity which various samples of soils and other tiny particles display when dusted into a cold chamber and Figure 2 shows crystals grown on such particles.

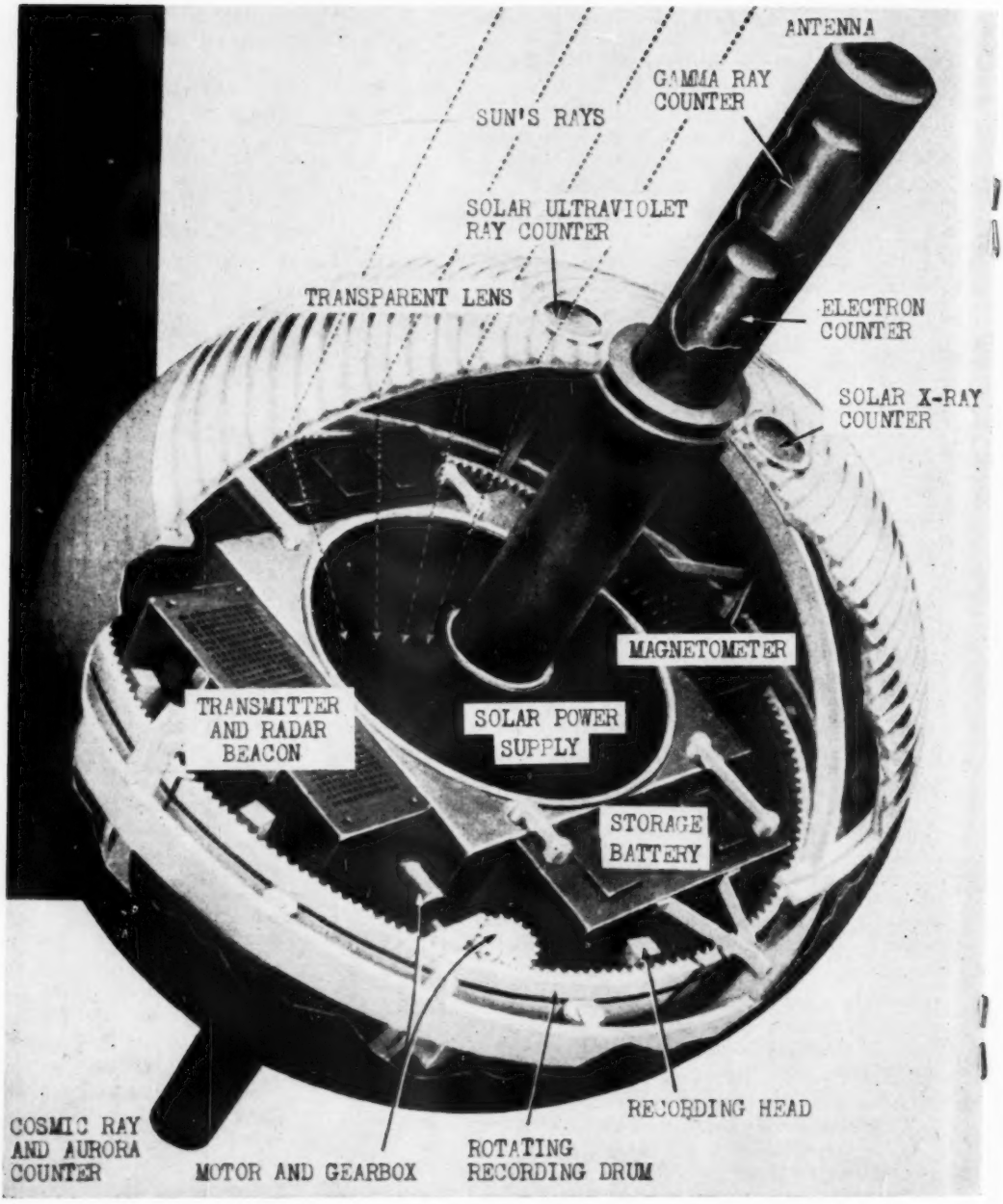
The Formation of an Aerosol in a Cold Chamber

A convenient and satisfactory method for introducing dust particles into a cold chamber to determine their effectiveness as ice crystal nuclei is to spread a pinch of the dust over a piece of coarse paper. The dust is then made airborne by giving the dustladen paper a sharp snap with the fingers. A more elegant method is to put a small sample inside a plastic "squeeze bottle." After giving the bottle vigorous shaking, it is allowed to settle for a few seconds (to get rid of the large particles and clumps), and then with the cap removed is squeezed one or more times, depending on the quantity of dust required. If the squeezing is done as a quick

(Continued on page 123)



Temperature-activity relationship of certain sublimation nuclei.



Artist's rendition of an earth-circling satellite, based on a concept of Prof. S. F. Singer of the University of Maryland. Prof. Singer's specifications—diameter of about two feet, weight 100 pounds, and speed 17,280 mph. conform closely to the type outlined in recent Government announcements. Popular Science photo from World Wide Photos.

EARTH SATELLITES:

What Will They Mean to Meteorology?

JOSEPH J. KELLY, *Martin Company, Maryland*

A FEW decades ago the mere mention of earth-orbiting in space vehicles was classed as science fiction and drew raised eyebrows or tolerant smiles from the majority of people. The subject was purposely avoided by sophisticated scientists and engineers since the necessary incentive, technology, and economic resources were not available and could not easily be visualized in the future.

In recent years, however, extensive progress in engineering and the physical sciences has made possible a re-examination of the potentialities of extra-atmospheric vehicles. This was evidenced by the announcement that the Government intends to sponsor the launching of a 40-pound "moonlet" which would circle the earth at an altitude of approximately 300 miles. The news prompted a flurry of generalized, misleading statements, some of which inferred that the benefits to meteorology would be revolutionary! It was asserted that the information acquired through the satellite would immediately enable meteorologists to issue far more precise short- and long-range weather forecasts than is now possible. Such unqualified statements, while they may later prove to be true, tend to create in the public's mind an expectation of too much, too soon.

It is logical to assume that the currently planned satellite, which will be operational in 1958 according to a recent announcement, will be the initial step in an increasingly active plan of space exploration. This program will undoubtedly present an opportunity to pursue active meteorological investigations of outer space areas through telemetering instrumentation in the vehicles. In anticipation of these inviting opportunities, meteorologists—in fact all who are interested in the progress of the science—must begin immediately to formulate a comprehensive, systematic approach to the problem. A definition, as well as an evaluation, must be made of the feasibility, utility, and priority of measurements to be made. Concurrently, this evaluation must be integrated with the

projected capabilities and limitations of the vehicles. A series of forward-looking research programs should be planned with a view of incorporating them into the vehicles as soon as increasing weight and space facilities permit.

It is vitally important that those interested in our science be cognizant of the present situation and its potential and be encouraged to contribute their ideas to its future developments. Thus a wider spectrum of ideas and opinions can be brought to bear on the subject, which by its very newness precludes the existence of experts and encourages original thinking.

Another problem, equally as important as what should be measured, concerns how the measurements should be made. For the initial effort it is likely that existing techniques and instruments will be used. As the programs expand and valuable experience is gained, specialized equipment will undoubtedly be developed particularly for use in satellite vehicles.

Suggested Measurements

Underlying the general problem of satellite utility is the more basic question of what specific measurements might possibly be made, regardless of their present practical value. This more imaginative approach presents a rare opportunity for physical theorists as well as those interested in advanced instrumentation. The following are a few ideas that have been suggested as interesting possibilities:

(1) From an analysis of specific bands in the infrared radiation coming from the earth, the temperatures of particular layers in the atmosphere or of the surface might be inferred.

(2) By studying the strength and direction fluctuations of the high frequency radio communication link as it sweeps through the atmosphere, a useful integrated means of measuring density might be established.

(3) A study of the atmosphere as a dielectric or nonconductor in an earth-atmosphere-ionosphere condenser, while not usually considered meteorological, might be undertaken.

(4) It is almost unnecessary to suggest that we will be interested in measuring solar radiation outside the atmosphere. Such a measurement will reveal previously unavailable data on the lower and upper regions of the spectrum, as well as data on the variations of the entire spectrum. Further study of the relation of solar radiation to trends and fluctuations in the general circulation would be a possibility.

(5) A study of meteoric dust as it influences the attenuation or weakening of radiation and as it affects the quantity of condensation nuclei might be considered.

(6) Albedo measurements of reflective surfaces would certainly be used in the initial effort. A relatively simple photocell, weighing only a few ounces, could be employed in a variety of ways; when oriented vertically, it should indicate the cloudiness over a given area at a given time. More elaborate mechanisms would permit rapid scanning of large areas, yielding a "picture" of the clouds. The variation in albedo caused by changes in the reflecting surface such as cloud cover, vegetation, and snow cover might be related to the earth's heat balance and general circulation.

Is the Trip Necessary?

An appreciation of the mechanical capabilities and limitations involved in sustaining a stable platform in an earth-circling orbit is necessary in formulating the meteorological programs. For example, when it becomes possible to launch satellites for solely meteorological purposes, the particular altitude, period, and flight path must be chosen to get the best results from the instrumentation. It is interesting to note that, while the proposed orbiting altitude is about 300 miles, almost 90 per cent of the atmosphere is below 10 miles. In this case measurements would be taken 290 miles above the bulk of the atmosphere in contrast to our present intra-atmospheric methods. The question arises, and it is at the core of the meteorological problem: "Is it worth the trip?"

The writer believes that it is definitely worth the effort to find out. He suggests that we might begin by conducting a Space Symposium with emphasis on meteorological problems as other scientific organizations have done, namely, the American Society of Mechanical Engineers, American Rocket Society, and the Institute of Radio Engineers. It is certainly not too early to attack the problem right now!

Simple Experiments

(*Continued from page 119*)

movement, a circular vortex ring will emerge and spread throughout the chamber. In this manner a certain degree of control may be exercised over the quantity of dust introduced into the chamber. A cardboard container such as a circular ice cream carton with a 1-inch circular hole cut in the lid will serve as a good substitute for a squeeze bottle.

Observations of the Nuclei

It is best to introduce the dust for the first time into a cold chamber free of supercooled cloud. In this manner it is possible to get a rough idea of the number and nature of the particles in the dust cloud. A supercooled cloud may then be formed, the temperature noted, and the number of ice crystals observed to form on the introduced particles. It will often be observed that 60 seconds or more will pass before any ice crystals appear. Presumably, this is due to the need for development of a frostlike layer on the particles before they start growing rapidly.

Occasionally a dust sample will contain particles which twinkle and scintillate in much the same manner as ice crystals. If such particles do not serve as ice nuclei, they fail to grow and are observed to coexist with the supercooled cloud. In the temperature range of − 10° C to − 15° C up to about 50 crystals per cubic centimeter will coexist with a supercooled cloud. They grow very rapidly, however, and in less than 30 seconds will become so large as to fall to the bottom of the chamber. If small, twinkling crystals persist in a supercooled cloud for a longer period, it may be assumed that they are not serving as ice crystal nuclei but have shiny surfaces.

Temperature of Ice Nucleating Activity of Natural Dust Particles

As a general rule, most natural dust particles now known, which serve as ice crystal nuclei, do not become effective until the temperature of the supercooled cloud reaches − 12° C to − 15° C. Many are not effective until the temperature is colder than − 20° C. This does not mean that better ones do not exist. Silver iodide, which will be described in the next chapter, has a temperature threshold close to − 4° C (24.8° F), but does not occur naturally except under very special circumstances. It is quite possible that natural materials will be discovered which will be even more effective than silver iodide. A search for such substances should be made and may be accomplished with the simple equipment we have described. Easily available dusts should be observed to start with and observations made, using at least three different temperatures such as − 7° C (17.6° F), − 13° C (8.6° F), and − 20° C (− 4° F). A "good" sample will remove all of the supercooled cloud within less than a minute at a temperature of − 20° C. If this happens at − 10° C, you may have made an important discovery!

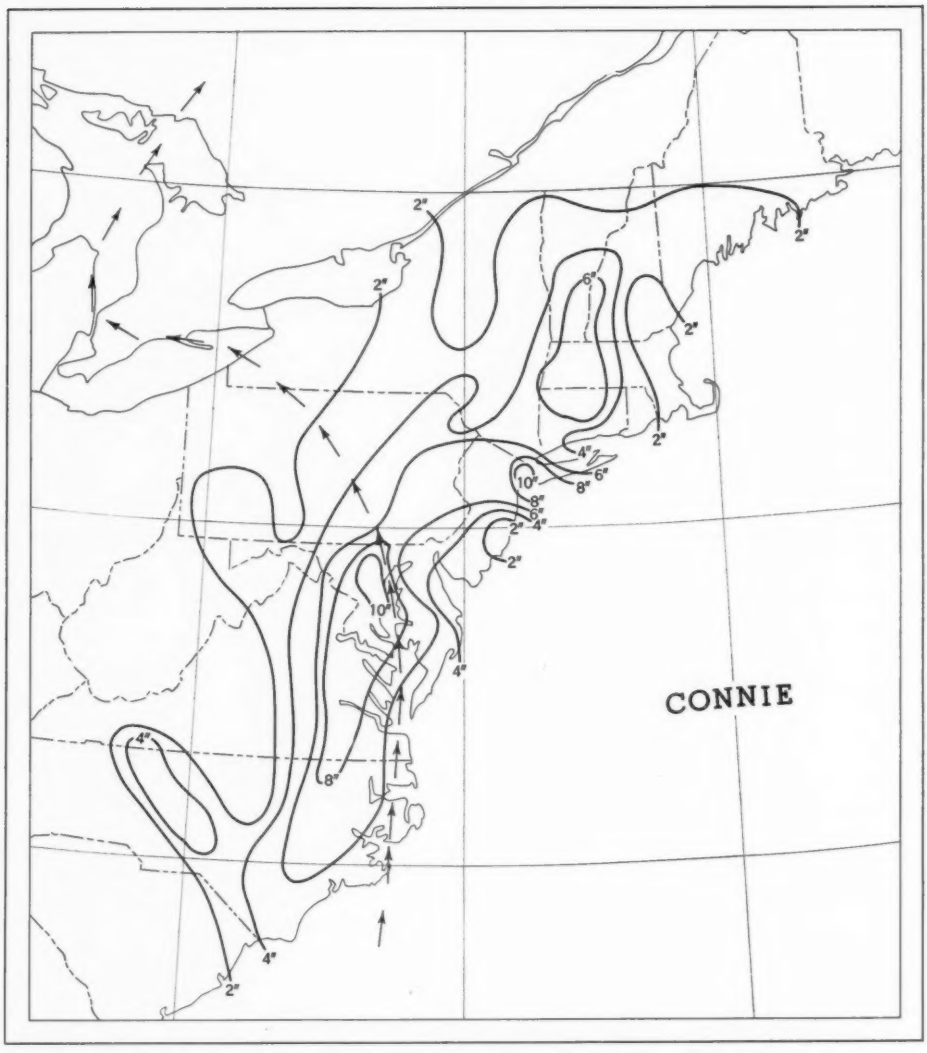
OPERATION OVERSEED

A cloud seeding project under the direct supervision of the President's Advisory Committee on Weather Control will commence operations in the Mt. Washington, New Hampshire, area shortly after 1 October. This will form part of the physical evaluation program of the Committee and will be under the supervision of Captain F. A. Berry, on loan to the Committee from the U. S. Navy. Mr. Robert B. Smith will serve as field director with offices in the Federal Building, Littleton, New Hampshire.

A battery of 5 to 24 silver iodide generators of different types, including those employed by commercial seeders, will be set up at distances from 5 to 8 miles in a westerly direction from the mountain. The staff of the Mt. Washington Observatory will be augmented to count the nuclei and ice crystal concentration at the summit.

It is hoped that "Operation Overseed" will yield further information relating to control of aircraft icing conditions, the role of overseeding in reducing precipitation, and the optimum ice crystal concentration for enhancing precipitation. A full report will be submitted to the President by 30 June 1956.

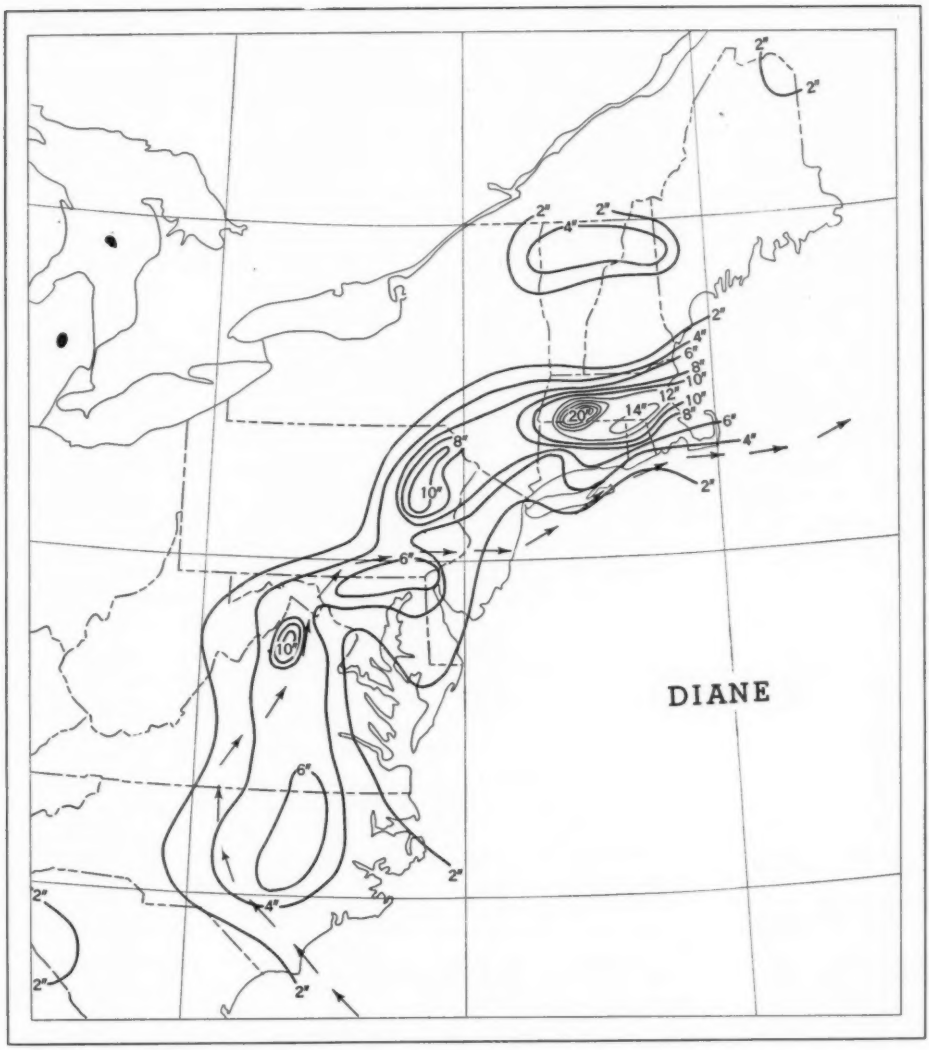
The work is being carried out by a public agency in the best interests of the nation. All persons are welcome to inspect the equipment and the conduct of the project.



Rainfall associated with Hurricane Connie, 10–15 August 1955. Based on preliminary data. Weather Bureau chart.

Hurricane Rains Cause Devastating Floods

H. C. SUMNER AND THOMAS J. O'CONNELL, *Climatological Services, USWB, Washington*



Rainfall associated with Hurricane Diane, 16–20 August 1955. Based on preliminary data. Weather Bureau chart.

THREE devastating hurricanes struck the eastern seaboard in 1954, spread havoc and destruction from the Carolinas to Canada, and focused the public eye on the threat of major destruction in future years. The 1955 hurricane season began with an unusual winter tropical storm which died in the spawning grounds of the Caribbean, to be followed at a more accustomed date by a relatively small storm, Brenda, which moved inland and dissipated over the Gulf states of Louisiana, Mississippi, and Alabama on 1–2 August.

Connie, the first full hurricane of the 1955 season, armed with 135 mph winds, stood poised off the Carolina coasts on 9–12 Au-

gust, as though undecided whether to strike inland or to wander seaward over the North Atlantic. Gusty winds dropped to about 100 mph as she crossed the coast on the 12th and then moved northward over eastern North Carolina and Virginia, up Chesapeake Bay, and through central Pennsylvania to Lake Erie with diminishing fury. The rains associated with Connie were heavy to excessive over the eastern states from North Carolina to New England. At La Guardia Field, New York City, a total of 12.20 inches fell in a 38-hour period on 12–13 August. Amounts in excess of 9 inches were registered in eastern Pennsylvania and central New Jersey. In western New England the totals for the Connie period exceeded 6 inches. Bank-full streams, some local flooding, and an almost complete saturation of the soils remained after Connie's passage. A few days later a squall line moved across the affected states and local thunderstorms deposited an additional 1–2 inches of rain in several localities. The stage was well set for flooding if more precipitation came.

News stories referred to Diane as the "kid sister" of Connie. She followed a remarkably similar track less than a week later, hesitated briefly off the Carolinas, and then headed inland on the 17th. Her winds were not as strong as those of Connie, but the damage caused in the Carolinas and in southern Virginia coastal areas was quite extensive, largely because of weakened conditions of seawalls, buildings, and trees after Connie's initial onslaught.

Though tides were high and there was some flooding on the Carolina coasts and along Chesapeake Bay, the winds were less than hurricane force over inland areas and subsided rather rapidly as the storm moved through central Virginia. Public anxiety subsided with the winds. The storm circulation, though greatly weakened, remained and pulled inland over southern New England, eastern New York and Pennsylvania vast quantities of moisture-laden tropical air. As the dying storm moved northeastward through this area and "rained itself out," the precipitation fell on the saturated soil and full rivers left by Connie. With no place left to go, the rains ran off the hills and produced the most devastating floods the valleys of eastern Pennsylvania, northwestern New Jersey, southeastern New York, and southern New England have ever experienced.

The portion of Diane's track over North Carolina and Virginia lay some 75 miles farther west than that of Connie, but on reaching Pennsylvania the second storm swung eastward, crossed New Jersey, and moved parallel to the coast just south of New England. The canopy of torrential rains covered the same areas previously deluged by Connie, although the band of heaviest downpours was about 50 to 100 miles to the north. From the Poconos of Pennsylvania, across the southern Catskills, and into the Berkshires of New England and eastward, rains in excess of 8 inches were reported. The greatest amounts, more than 18 inches, fell to the northwest of Hartford, Connecticut, in the highlands where many small streams rise. The airport for Hartford at Windsor Locks had 13.97 inches in 36 hours on 18–19 August, and amounts were higher a few miles further northwest. Boston and suburbs also were in the excessive rain belt. Logan Airport at sea level received 8.40 inches in 24 hours on 18–19 August. This swelled the total August precipitation to 17.09 inches, well above the greatest amount for any calendar month since complete records were commenced in 1818.

The combined totals of the two tropical storms exceeded 20 inches in a number of localities. On the eastern slopes of the Pocono Mountains flash floods tore through numerous narrow river valleys. An estimated 75 persons lost their lives at one place near Stroudsburg, Pennsylvania, when rapidly rising waters of Broadhead Creek swept away a summer camp and almost all its summer visitors. In the valleys of Connecticut at least 54 deaths occurred in the highly populated industrial cities. And there were a few scattered fatalities in other eastern states.

The loss of life in excess of 200 was moderate when compared with 494 fatalities listed for the 1938 New England hurricane. There is, however, no precedent for the estimated $1.6 billion in property damage caused by Diane's rains. The damage from these two hurricanes tops by more than three times the combined amounts listed for two of our greatest national disasters, the Chicago Fire of 1871 and the San Francisco Earthquake of 1906.

Floods. WILLIAM G. HOYT AND WALTER B. LANGBEIN, Princeton Univ. Press, Princeton, N. J., 1955. 469 p., illustrated $7.50.

If this authoritative and readable book on floods and flood control had been published in any other year of this century it would have been "timely," for there has scarcely been a year when major floods have not occurred somewhere in the United States. In a number of years (notably 1903, 1909, 1913, 1927, 1935, 1936, 1937, 1943, 1945, 1947, and 1951) damage has been over $300 million and in 1913, 1937 and 1951 damage was close to $1 billion. So it is not surprising that this year (1955) saw a "flood-to-end-all-floods" in New England and the Middle Atlantic States, with damage running to $1.5 billion or more and over 100 lives lost. Yet a perusal of the statistics in the two well organized chapters on "Flood Damage" and the "Chronological Histories of Individual Floods" (Chap. 4 and 10) will give the reader the overwhelming impression that this is just one of hundreds or thousands of "record" floods that have occurred, and will occur somewhere in the United States from the beginning to the end of time, wherever there is melting snow, cyclonic storm, hurricane rainfall, or local cloudbursts. In fact the book reveals that many of the worst floods (e.g. the Ohio flood of 1936 or Kansas City flood of 1951, which was the record flood up to the time of publication of the book, in terms of property damage) could have been much worse if meteorological conditions had been only slightly different.

There is scarcely a page in the 10 chapters of nearly 500 pages in this book which does not carry some interesting fact or idea. The book starts with two pages of colorful accounts of floods from around 2957 B.C. to 2000 A.D.!! Chapters dealing with (1) flood problems; (2) flood plains, rainstorms, thunderstorms, hurricanes, maximum rainfalls, snow, ice jams; (3) life history of a flood; (4) flood damage; (5) adaptation to floods, zoning, insurance, forecasting, relief, reconstruction; (6) flood control, dikes, levees, channel improvements, diversion of flood waters, reservoirs, land use measures; (7) legal aspects; (8) federal policy; (9) basin projects; (10) individual flood history (1543–1951).

A good perspective of the universality, magnitude, and catastrophic nature of the worst floods can be had from the 31 well-chosen photographs (mostly aerial) of memorable floods in all sections of the United States. One who has, like the reviewer, awakened (fortunately) in the night to find water running through the house, level with one's bed, and had to scramble to safety over the tops of furniture, will find these photographs and accounts vividly awakening long forgotten memories of near-disaster.

The positive side of floods is not forgotten, either, in the authors' well balanced treatment. Some of these subjects are: replenishment of reservoirs, recharge of ground water, and building up of the fertility of the flood plain, not to mention the intangible psychological advantages for those who survive, especially those who "rise to the emergency" and help in rescue work or rehabilitation.

Finally there is an excellent geographical index of about 2000 outstanding floods mentioned in the text and an equally excellent bibliography and general index. All in all no reader will find this book dry reading, and like Flora's, well-known book on *Tornadoes* or Tannehill's book on *Hurricanes*, it is well worth having as a handy reference work for almost daily use by meteorologists, hydrologists, engineers, and all those interested in Public Safety from either the humane, the social, political, or economical (financial, insurance, industrial or transportation) points of view.

Malcolm Rigby

MOTION PICTURES WANTED

Frank Capra is preparing a scientific film on the subject of weather. He is interested in obtaining information about available 16mm or 35mm films or stills on various meteorological phenomena. If acceptable material is located, rights for duplication will be purchased. He requests anyone with knowledge of such film to send information only, NOT FILM, to Film Editor, Frank Capra Productions, Inc., 9100 Sunset Boulevard, Los Angeles 46, California.

Weatherwatch

An Active Meteorological Summer

DAVID M. LUDLUM, *Editor*

Summer is reputedly the time of the year when the weather elements are less active, and much of the hemisphere enters a sort of doldrum-like existence. Professional meteorologists then go on vacation like other people, and some amateur weathermen are accustomed to fold up shop completely. It takes a hurricane or the first cold snap of the fall to bring the local meteorological spokesman back into the public limelight. Summer of 1955, however, will long be remembered by weathermen, professional or otherwise, for they had more to sweat about and to talk about than in any other recent year.

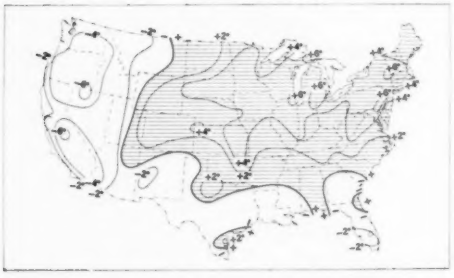
The Pacific Coast had record cold at the beginning of the period under study and record heat at the end, with a dosage of the heaviest smog in history thrown in for the residents of Los Angeles. In July the Northeast was in the grips of a growing drought and fears were expressed for the water supplies of key industrial cities; in August the greatest floods in their histories rolled through many of the same cities. Throughout the two-month period record high temperatures persisted over most of the Northeast and Middle West, and finally spread into the Far West in late August. And three hurricanes developed in tropical waters and pursued tracks that crossed the coastline of the United States. Two of them followed rather similar tracks to Virginia, whence they went on individual ways, much to the dismay of watchful forecasters and to the discomfiture of an alerted public.

Whatever the difficulties with the weather, all eyes turned to Washington for assistance. It was either relief from drought or relief from floods that was sought through a number of federal agencies. The Department of Agriculture was hard pressed to find a solution to the problem of bumper crops, since another season's favorable weather had overflowed the harvest bins with yields second only to 1948. Whether it was smog or the hurricane, special study groups were being formed at the Nation's Capital. Fortunately, a new "appropriations climate" exists in federal weather circles. And in the private field, *The New York Times* urged that our research-minded foundations might turn their attention to "our backward science." So not only the desire, but also the "where-with-all" appears to be at hand to make a start in tackling some of our most pressing meteorological problems.

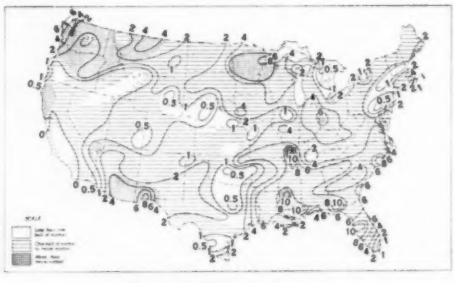
JULY CIRCULATION—As the month of June drew to a close, the blocking action over northeastern Canada that had controlled the flow of the weather elements over most of the continent began to weaken and to shift westward. In its place a polar vortex formed and gave the Arctic regions a rather stormy summer season, a period when there was much abnormal shipping activity in northern waters in connection with the establishment of new radar and weather stations in the Far North.

The chief feature on the late June weather map for eastern United States and southern Canada was a strong polar anticyclone which drifted southward from northwestern Canada at a slow pace. It became greatly modified in its southeastward progress over the Eastern States and finally joined in the vicinity of the Carolinas with an expanding and strengthening Bermuda-Azores high. This vast anticyclonic area became a permanent feature of the weather map for the next sixty days. It was the culprit in setting the stage for the development of the greatest July heat wave in the history of many Middle Western and Northeastern localities, and the heat regime persisted into August, ever expanding its area of domination until at the close of the period it had gripped even the Pacific Coast. It was the persistence of the July–August heat that made its mark in the record books; few absolute

MONTH OF JULY 1955



Departure of Mean Temperature from Normal in degrees F. USWB chart.



Total Precipitation in inches. USWB chart.

maxima were broken, but high daily minima kept the mean far above the average.

The position of the anticyclonic cell over the eastern part of North America and across the western Atlantic Ocean was somewhat north of a normal summer position. The greatest plus departures from normal were found to the north of the Ohio Valley and north of Virginia. Thus, the anticyclonic circulation around the southern periphery of the high, over Florida and the Gulf Coast, was from the tropical seas to the east and southeast. Onshore winds brought slightly cooler than normal air over the Southland with the result that July and August were below normal in temperature most of the summer, in direct contrast to the sweltering North.

The key to the weather pattern of July was the existence of much stronger than normal ridges and deeper than normal troughs, a condition which usually makes for marked temperature contrast across our nation. While eastern sections were baking and central sections beginning to brown, the country west of the Rockies had a very cool July, to continue the regime of below normal months that commenced last November. Residents of the Far West take little stock in reports of the general warming of our climate since they have experienced very little evidence of such in the last decade.

A marked north-south trough stretched along the Pacific Coast with pressure readings well below the summer normal. This caused a flow of cool, moist Pacific air into the Western States, resulting in generally cloudy skies, below normal temperatures, and heavy precipitation for the season. There was much cyclonic activity over Oregon-Washington during July. Record minima for July were set at several Plateau stations in Nevada and Utah, and snow fell at relatively low elevations in Oregon on 1 July!

The heat in the East gave inhabitants of the large industrial cities a very uncomfortable time. Sales of fans and air-conditioning equipment reached new highs. New York City had its warmest calendar month in Weather Bureau history with a July average of 79.7°, or 5.1° above normal. This was 0.8° higher than the previous warmest July in 1952. There were 11 days on which the mercury climbed to 90° or higher, also a new record. At La Guardia Field the reading reached an even 100° on the 22nd and 23rd. Old military records for New York City, which date back to 1822, show that July 1825 was the warmest in pre-Weather Bureau history with a mark of 81.3°, but these observations were taken and calculated in a different manner. No other July in these early records could match the figure of July 1955!

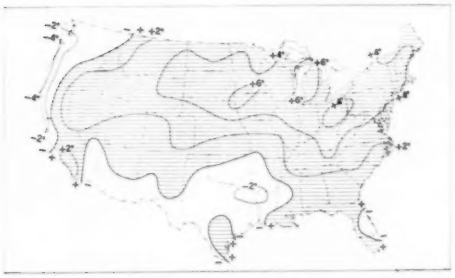
AUGUST—The main development in the circulation pattern for August was the gradual filing of the Pacific Coast trough. Though it remained a recognizable feature for the first three weeks, it did not play its important role of importing cold air into the West. With the trough flattened out, air flow became more westerly instead of northwesterly, cyclonic activity disappeared, and the precipitation regime returned to its almost rainless normal summer character. The westerlies were now found much further north in Canada, permitting clear skies and pleasant temperatures to the western vacation lands.

The great continental anticyclone of July remained as the principal feature of the pressure map throughout August. With the Pacific trough diminished in depth and extent, the high pushed westward until it stretched from coast to coast. The centers of maximum departures from normal summer pressure were generally along the 42nd parallel: in northern California, Iowa, and New England. Air flow over this vast area was generally from southwest to northwest. Cold fronts seldom penetrated far into the United States, though there was a short respite from the heat in the second week of August.

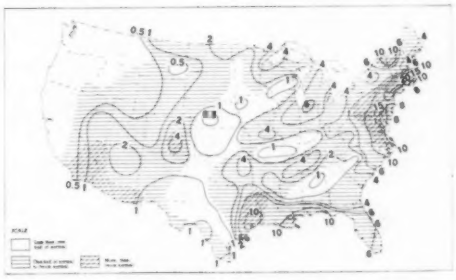
In the East the epicenter of extreme heat, which had been over the eastern Lakes and Northeast in July, shifted westward also. The greatest abnormalities were experienced in the Upper Lakes and in the middle Missouri Valley. Sioux City, in northwestern Iowa, was typical of the hot August in the eastern Plains. Airport readings there were higher than 90° on every day from 25 July to 5 August and again from 14 to 28 August. During these two periods the daily maxima exceeded 100° on ten occasions. Chicago had a very warm summer—there were more plus 90° days in 1955 than in any previous summer, due to a couple of hot mid-September days.

The continental anticyclone, working westward all summer, finally reached the far Southwest. Toward the end of August it displaced the normal thermal low there and set the stage for a major heat wave by pouring out hot winds from the interior. On the last day of August the heat broke

MONTH OF AUGUST 1955



Departure of Mean Temperature from Normal in degrees F. USWB chart.



Total Precipitation in inches. USWB chart.

through to give San Diego and Los Angeles airports near the sea readings of 98° to start the "unusual" southern Californian heat wave. For ten days the mercury soared to 100° or above in downtown Los Angeles. An all-time high of 110° was reached on 1 September to break a mark set in July 1891. The heat extended all over the Pacific states except the immediate coast in the Northwest. Readings well above 100° were reported in Oregon where they had snow on 1 July!

1955 HURRICANES—The position of the Azores-Bermuda high, of course, plays a very important role in both the birth and development of hurricanes and also is a guiding factor in determining their tracks. In the summer of 1955, with the semi-permanent anticyclone well north of a normal position and centered inland, an opportunity was given the tropical areas to send northward a numerous batch of unwelcome visitors. Three of these storms fall within the limits of our period, and their major effects in the United States are discussed on page 125. The most plausible theory of hurricane generation considers them as originating in easterly waves that move along the southern border of the Azores-Bermuda high. These waves are supposed to generate in old polar cold fronts that sweep southeastward across the Atlantic and reach tropical areas where they form perturbations on the normal easterly circulation. Under favorable conditions these easterly waves move westward to the West Indies and the Caribbean Sea; sometimes they develop into full-fledged hurricanes when nearing the continent. Connie and Diane had such histories. Along with Brenda from the Gulf, they all crossed the United States coastline in August; though not noteworthy as wind storms, all three were excellent rain producers.

Weather Support for the Atomic Tests

(*Continued from page 115*)

At least one record was probably set during the tests of 1955. On one of the shots it appeared possible that fall-out might take place in the vicinity of the command post when conditions were otherwise quite favorable. Accordingly, it was decided to evacuate the command post within ten minutes after the shot. This also necessitated evacuating the Mercury rawinsonde unit. In an attempt to get the post-shot data, it was decided to make a release and turn the GMD-1A (rawin tracking unit) on to "automatic" before evacuation. Working at top speed, the crew completed the inflation, base-line check, and release within the ten-minute period of grace. When they returned, two and one-half hours later, they found that the GMD-1A had successfully completed an 86,000 foot sounding by itself.

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People in New York City like to hear about their hurricane prospects. On 19 and 20 September, when Ione was lurking to the South, the total calls were 406,899 and 358,798. The former established a new record of total calls in a 24-hour period.

CORRECTION—In the August 1955 *Weatherwise*, the figure caption on page 94 should be amended to state that the "fronts" which extend south and east of the center of Hazel correspond to isochrones showing the peak gust as related in the text on page 93.

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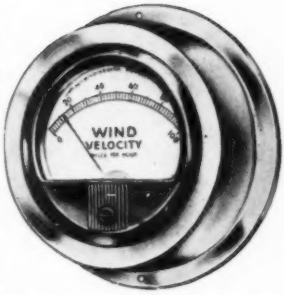

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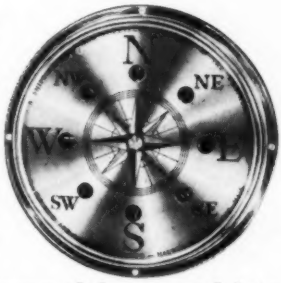

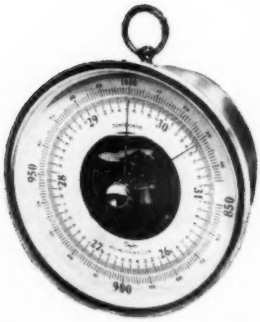

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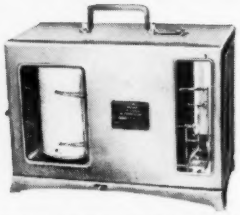

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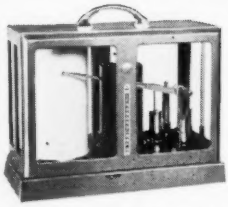

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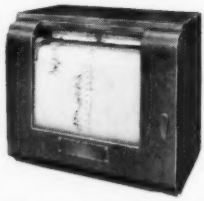

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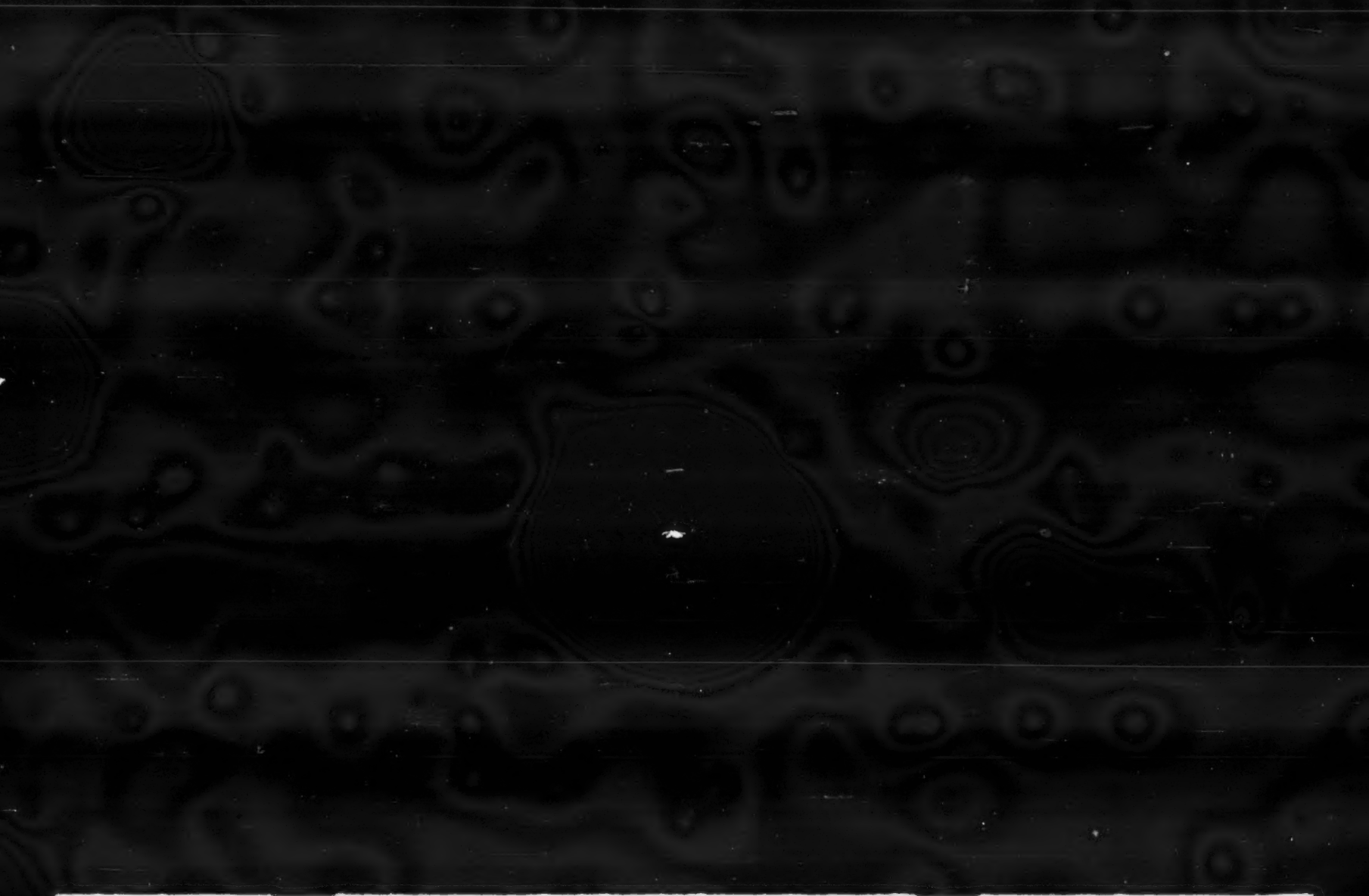
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